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ABSTRACT

A recent survey of 60 commercial computer assisted instruction (CAI) programs found that most of the programmed lessons used few or no graphics to communicate the main points. An Instructional Graphics Checklist was developed to reflect the research findings about the use of pictures in instruction and to serve as an informal evaluation instrument for educators to employ in determining whether a CAI lesson is making appropriate use of graphics in instruction. The checklist covers quantity of graphics, relevance of graphics to the topic and lesson, and types of graphics used (representational, analogical, or abstract). The checklist was applied to two CAI lessons: Green Globes, an algebra plotting game; and Dragon Mix, a math facts game. Based on the application of the checklist, the two lessons differ considerably, with Green Globes making excellent use of graphics, and Dragon Mix showing poor use of graphics. Twenty-eight references and a copy of the checklist are included. (LMM)

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The Instructional Graphics Checklist:
A Look at the Design of Graphics in Courseware

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An overemphasis on verbal instruction has been blamed in part for the current crisis in education as the preponderance of new terminology in textbooks exceeds the learner's ability to absorb new vocabulary. For example, secondary textbooks in science were found to present 10-20 new terms per page and well over 10,000 new terms per book (Yager, 1983). In contrast, science textbooks were found to have only 1-2 instructional pictures per page (Brody, 1982-83). Yet there is convincing evidence that relevant pictures can significantly facilitate learning for both adults (Alesandrini, 1984a) and children (Pressley, 1977). Microcomputer-based instruction offers the potential of presenting information in a pictorial or graphic form rather than in an all-verbal format, yet this potential has not been fully explored or developed. A recent survey of 60 commercial CAI lessons found that most of the lessons used few or no graphics to communicate the main points (Alesandrini, 1984b). The Instructional Graphics Checklist was developed to reflect the research findings about pictures in instruction and to serve as an informal evaluation instrument for educators to use in determining whether a CAI lesson is making appropriate use of graphics in instruction.

Part One: Use of Graphics

The incidence of graphics in CAI lessons is difficult to quantify because the number of graphics shown depends on the length of the

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lesson. For purposes of the checklist, the use of graphics in the lesson was quantified by the percentage of total lesson time that involved display of graphics on the display screen. The four categories include: no graphics displayed, graphics displayed at least 1/4 of the time, 1/2 of the time, and more than 1/2 of the time. Research on pictures generally supports the use of graphics (Alesandrini, 1984a;1982;in press). However, the studies on picture effects vary widely on the basis of frequency of picture incidence. For example, researchers report using one picture to illustrate each concept or sentence (Guttmann, Levin, & Pressley, 1977), one picture to illustrate each paragraph (DeRose, 1976), several pictures per lesson (Vernon, 1954), or one picture per lesson (Wardle, 1977). But since studies generally show that pictures facilitate recall of information portrayed in the picture, the checklist reflects the notion that a higher incidence of pictures is desirable. It should also be noted that most of the picture research is based on studies that did NOT involve computer-based instruction. However, several studies confirm the picture effect for CAI (Alesandrini & Rigney, 1981; Rigney & Lutz, 1976).

Part Two: Relevance of Graphics

It may seem intuitively obvious that graphics should be related to the topic of the CAI lesson yet any casual examination of current courseware usually reveals an abundance of irrelevant graphics. It is not surprising that research studies have shown that irrelevant or inaccurate pictures as well as those used only for embellishment can fail to facilitate memory and may even have adverse effects (Baker & Popham, 1969; Peeck, 1974). Of course, graphics do attract attention and can spark the learner's motivation. But in order to be truly effective, graphics in CAI should be relevant to the topic and content of the lesson. Finally, the graphics may also facilitate learning if they are used to give feedback after the

learner responds. Again, it seems intuitively obvious that wrong responses should not be followed by "rewarding" graphics (although informative visual feedback after both correct and wrong answers can facilitate learning).

Part Three: Types of Graphics

Instructional pictures have been classified on the basis of how they convey meaning including representational, analogical, and abstract (or arbitrary) (Groppe, 1963; Knowlton, 1966). Research studies indicate that each of the three types facilitates learning (Alesandrini, 1984a; Levie & Lentz, 1982). Yet many CAI lessons may be using only the first type of graphics when pictures are used at all (Alesandrini, 1984b). (The terms "pictures" and "graphics" are used interchangeably in this paper.) The checklist reflects the fact that each of the three types may be used to either present information initially or give informative feedback after the learner responds to questions or problems.

Representational Graphics. Graphics that are representational have also been termed "realistic" (Knowlton, 1966) because the category refers to pictures that are isomorphic with the objects or topics that they represent. Graphics in this category may vary, however, on the basis of amount of realistic detail so the term "representational" is less confusing. In courseware, representational graphics include line drawings, shaded drawings, silhouettes, and realistic symbols.

Representational pictures can either portray information directly or indirectly. Tangible objects or concepts may be represented directly. However, it is not always obvious how to portray a concept that has no tangible existence. Although abstract concepts cannot be directly portrayed, they may be portrayed indirectly by showing their effects, results, instances, or exemplars (Groppe, 1963). It may be impossible to

directly portray the topic of "heat", for example, but its effect on solids, liquids, and gasses may be shown via melting, boiling, and expansion of gas-filled objects, respectively. Another approach to illustrating abstract concepts representationally is to portray a concrete associate of the concept (Jones, 1983). Seasons of the year may be portrayed by showing the typical dress and activities of people during that season. Some educators have made up pseudo-examples that portray what the educator thinks the concept might look like if it were tangible (Cantu & Herron, 1978).

When graphics are used in courseware, they are typically representational. This type of graphics appeared in 40% of the math lessons surveyed, 71% of the science lessons, 25% of the CAI lessons in language arts, and 21% of the social studies lessons (Alesandrini, 1984b). Only in the area of math was another category of graphics more prevalent—namely, abstract graphics such as charts and graphs. In all areas except social studies lessons, representational graphics were used more often to present information than to give feedback despite the evidence that visual feedback can facilitate learning.

Analogical Graphics. Another category of graphics has been termed analogical because the concept or topic is conveyed by showing something else and implying a similarity. The benefit of this type of graphics is based on the assumption that new information will be better learned and remembered if it can be related to prior knowledge (Reigeluth, 1983; Wittrock, 1974; 1977). Studies show that this type of picture can facilitate learning (Alesandrini, 1984a). For example, visual analogies have been used to facilitate both learning (Mayer, 1975; Royer & Cable, 1976) and problem solving (Gick & Holyoak, 1983).

Of the 60 CBI packages surveyed, none made use of analogical graphics.

Educators should be concerned if they find a total lack of analogical graphics since theory and research support the value of analogical graphics in CAI. Verbal analogies have also proven facilitative and educators may want to look for the inclusion of verbal analogies in a CAI lesson if no visual analogies are present.

Abstract Graphics. The final category in the Checklist is abstract graphics also referred to as arbitrary or logical graphics. These visuals do not look like the things that they represent but are related abstractly or conceptually. Knowlton (1966) referred to this type of picture as "logical". Abstract graphics include graphs, flowcharts, networks, maps, tree diagrams, and other schematized charts and diagrams. This category is very useful in structuring and organizing verbal text. Abstract graphics can be used to facilitate learning when no other type of picture is possible or feasible. Again, research results support the value of this category of graphics in instruction (Alesandrini, 1984a).

Although computers are well suited to the display of abstract graphics since this type of visual is relatively easy for the instructional designer to create via computer, few CAI lessons surveyed contained abstract graphics. Of the 60 CAI packages surveyed, only 13 (22%) used abstract graphics of any kind to present information. Twelve of the lessons used abstract graphics to provide informational feedback after the learner responded. Of the 13 lessons that used abstract graphics to present information, nine of the lessons were in the area of mathematics. None of the lessons in social studies used this type of visual. Yet flowcharts, organizational charts, tree diagrams, structural networks, and hierarchical maps have proven valuable in learning from text (Moore & Readence, 1983). It appears that CAI lessons could do much better in taking advantage of abstract graphics.

An Example Application of the Checklist

The Checklist was designed to provide the educator with some general guidelines for determining whether a CAI lesson is using instructional graphics appropriately and fully. It serves as an informal means of determining the instructional value of a CAI lesson based on its use of graphics. The Checklist was applied to two different CAI lessons that differed considerably in their use of graphics. For comparison purposes, the Checklist was quantified by scoring all items checked as one point except for items 1, 5, and 10. The latter three items are negative characteristics of a CAI lesson and, therefore, each detracted a point from the score. One reason the Checklist is described as "informal" is that there is yet no evidence regarding the relative contribution that each characteristic listed on the checklist makes to the effectiveness of a CAI lesson. For example, we don't know if analogical graphics are equally important to representational graphics or if one or the other type should be given more weight. Since no data is available regarding relative contribution of these factors to lesson effectiveness, all positive characteristics were weighted equally in determining the score. Similarly, since no data is available about the relative detriment of the negative characteristics, they were weighted equally in detracting from the total score. A "perfect" score using this Checklist would be 14. Three categories were arbitrarily designated as follows: Below 4, Poor Use of Graphics; 5-9, Good Use of Graphics; and 10-14, Excellent Use of Graphics.

The two lessons used in the comparison include Green Globes, an algebra plotting game, and Dragon Mix, a math facts game. The first lesson uses relevant graphics while the latter uses irrelevant graphics that presumably make the lesson fun for the learner. The application of the Checklist to these two lessons is given on the following page ("G" stands for Green

Globs and "D" for Dragon Mix). The Checklist yielded a score of 11 for Green Globes, indicating excellent use of graphics, compared to a score of 3 for Dragon Mix, indicating poor use of graphics. It should be noted that each of the lessons may have numerous other favorable or negative characteristics that affect their usefulness in education. However, based on the application of this checklist, the two lessons differ considerably on the basis of their effective use of instructional graphics.

There are many important elements of lesson evaluation that should be considered when selecting CAI lessons for classroom use. This paper discussed the contribution of instructional graphics to effective CAI and presented a checklist that might help the educator determine if a lesson is making good use of graphics. However, the Checklist can only guide, not decide. It is left to the educator to determine if a particular CAI lesson is appropriate and valuable for his or her classroom.

Instructional Graphics Checklist

Lesson Title _____

Publisher/Year _____

Subject Area/Level _____

Please check each characteristic below that applies to the lesson.

Part One. Use of Graphics

- _____ 1. No graphics
- G D 2. Graphics shown at least 1/4 of the time
- G D 3. Graphics shown at least 1/4 to 1/2 of the time
- G D 4. Graphics shown more than half of the time

Part Two. Relevance of Graphics

- D 5. Graphics used to decorate
- G D 6. Graphics used to motivate or interest
- G 7. Graphics used to direct attention to the content
- G 8. Graphics used to present the content
- G D 9. Graphics used to reward correct answers
- D 10. Graphics used to reward wrong answers

Part Three. Types of Graphics

- _____ 11. Representational graphics used to present content
- _____ 12. Representational graphics used to give feedback
- G 13. Analogical graphics used to present content
- G 14. Analogical graphics used to give feedback
- G 15. Abstract graphics used to present content
- G 16. Abstract graphics used to give feedback

Scoring: Deduct 1 point each if you checked items 1, 5, or 10. Add 1 point for each of the other checked items.

Below 4: Poor

5-9: Good

10-14: Excellent

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